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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/677,100	09/30/2003	Dimitry S. Vladimirov	2050.2.13	4098

36491 7590 10/21/2004

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EXAMINER	
THANGAVELU, KANDASAMY	

ART UNIT	PAPER NUMBER
2123	

DATE MAILED: 10/21/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	**Application No.** 10/677,100	**Applicant(s)** VLADIMIROV ET AL.	
	Examiner Kandasamy Thangavelu	**Art Unit** 2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 September 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-16* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-16* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *30 September 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date *August 23, 2004* .

4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. Claims 1-16 of the application have been examined.

Information Disclosure Statement

2. Acknowledgment is made of the information disclosure statements filed on August 23, 2004 together with copies of the patents and papers. The patents and papers have been considered in reviewing the claims.

Drawings

3. The drawings submitted on September 30, 2003 are accepted with the following exception. Specification Page 13, Line 17 refers to Figure 6 and describes it from Page 13, Line 17 to Page 14, Line 7. However, only five figures were sent with the application and Figure 6 is missing. Applicants are required to send Figure 6.

Specification

4. The disclosure is objected to because of the following informalities:

Page 5, Lines 4-5, "the component can be optimize for thermal performance" appears to be incorrect and it appears that it should be "the component can be optimized for thermal performance".

Page 7, Lines 2-3, "is measured in Watts/K*m^2 or (W/K*m)" appears to be incorrect and it appears that it should be "is measured in Watts/K*m^2 or (W/K* m^2)".

Page 7, Lines 9-10, "as measured by the thermal imaging system at some time t_{imaged} during the test t_0, or zero time" appears to be incorrect and it appears that it should be "as measured by the thermal imaging system at some time t_{imaged} during the test, or zero time t_0".

Page 7, Lines 13-14, "(wall thickness) through the line tangent to A_i" appears to be incorrect and it appears that it should be "(wall thickness) through the line normal to A_i".

Page 8, Line 3, "h_o = the external heat transfer of the external surface" appears to be incorrect and it appears that it should be "h_o = the external heat transfer coefficient of the external surface".

Page 8, Line 5, "The value is measured in W/K*m" appears to be incorrect and it appears that it should be "The value is measured in W/K* m^2".

Page 8, Line 27, "$h_i = (T_i - T_o)^* C_p {}^*p^*V]/[A_i {}^* t_{imaged} {}^*(T_a - T_i)]$" appears to be incorrect and it appears that it should be "$h_i = (T_i - T_o)^* [C_p {}^*p^*V]/[A_i {}^* t_{imaged} {}^*(T_a - T_i)]$".

Page 9, Line 18, "$q = h_o{}^* A_i{}^*(T_2 - T_b)$" appears to be incorrect and it appears that it should be "$q = h_o{}^* A_i{}^*(T_o - T_b)$".

Page 13, Line 27, "mass storage 606 may employed to store" appears to be incorrect and it appears that it should be "mass storage 606 may be employed to store".

Appropriate corrections are required.

Claim Objections

6. The following is a quotation of 37 C.F.R § 1.75 (d)(1):

> The claim or claims must conform to the invention as set forth in the remainder of the specification and terms and phrases in the claims must find clear support or antecedent basis in the description so that the meaning of the terms in the claims may be ascertainable by reference to the description.

7. Claims 1- 4, 5-8, 10, 12 and 13-16 are objected to because of the following informalities:

Claim 1, "redesigning and reevaluating the design of the interior fluid passage until the internal and external heat transfer are equal" appears to be incorrect and it appears that it should be "redesigning and reevaluating the design of the interior fluid passage until the internal and external heat transfers are equal".

Claim 4, "$h_i = (T_i - T_o) * C_p * p * V] / [A_i * t_{imaged} * (T_a - T_i)]$" appears to be incorrect and it appears that it should be "$h_i = (T_i - T_o) * [C_p * p * V] / [A_i * t_{imaged} * (T_a - T_i)]$".

Claim 4, "as measured at some time t_{imaged} during the test $t_{0,}$ or zero time" appears to be incorrect and it appears that it should be "as measured by the thermal imaging system at some time t_{imaged} during the test, or zero time t_0".

Claim 4, "(wall thickness), through the line tangent to A_i" appears to be incorrect and it appears that it should be "(wall thickness), through the line normal to A_i".

Claim 4, "h_o = the external heat transfer of the external surface at area A_0" appears to be incorrect and it appears that it should be "h_o = the external heat transfer coefficient of the external surface at area A_0".

Claim 5, "balancing heat transfer between the internal surface of the internal fluid passage and the internal fluid with an external surface of the turbine blade and an external fluid" appears to be incorrect and it appears that it should be "balancing heat transfer between the internal surface of the internal fluid passage and the internal fluid with heat transfer between an external surface of the turbine blade and an external fluid".

Claim 8, "$h_i = (T_i - T_o)^* C_p *p*V]/[A_i * t_{imaged} *(T_a - T_i)]$" appears to be incorrect and it appears that it should be "$h_i = (T_i - T_o)^* [C_p *p*V]/[A_i * t_{imaged} *(T_a - T_i)]$".

Claim 8, "as measured at some time t_{imaged} during the test $t_{0,}$ or zero time" appears to be incorrect and it appears that it should be "as measured by the thermal imaging system at some time t_{imaged} during the test, or zero time t_0".

Claim 8, "(wall thickness), through the line tangent to A_i" appears to be incorrect and it appears that it should be "(wall thickness), through the line normal to A_i".

Claim 8, "h_o = the external heat transfer of the external surface at area A_0" appears to be incorrect and it appears that it should be "h_o = the external heat transfer coefficient of the external surface at area A_0".

Claim 10, "wherein the apparatus further comprise a thermal imager" appears to be incorrect and it appears that it should be "wherein the apparatus further comprises a thermal imager".

Claim 12, "$h_i = (T_i - T_o) * C_p * p * V]/[A_i * t_{imaged} * (T_a - T_i)]$" appears to be incorrect and it appears that it should be "$h_i = (T_i - T_o) * [C_p * p * V]/[A_i * t_{imaged} * (T_a - T_i)]$".

Claim 12, "as measured at some time t_{imaged} during the test t_0, or zero time" appears to be incorrect and it appears that it should be "as measured by the thermal imaging system at some time t_{imaged} during the test, or zero time t_0".

Claim 12, "(wall thickness), through the line tangent to A_i" appears to be incorrect and it appears that it should be "(wall thickness), through the line normal to A_i".

Claim 12, "h_o = the external heat transfer of the external surface at area A_0" appears to be incorrect and it appears that it should be "h_o = the external heat transfer coefficient of the external surface at area A_0".

Claim 13, "balance heat transfer between the internal surface of the fluid passage and the internal fluid with an external surface of the turbine blade and an external fluid" appears to be incorrect and it appears that it should be "balance heat transfer between the internal surface of the fluid passage and the internal fluid with heat transfer between an external surface of the turbine blade and an external fluid".

Claim 16, "$h_i = (T_i - T_o) * C_p * p * V]/[A_i * t_{imaged} * (T_a - T_i)]$" appears to be incorrect and it appears that it should be "$h_i = (T_i - T_o) * [C_p * p * V]/[A_i * t_{imaged} * (T_a - T_i)]$".

Claim 16, “as measured at some time t_{imaged} during the test t_0, or zero time” appears to be incorrect and it appears that it should be “as measured by the thermal imaging system at some time t_{imaged} during the test, or zero time t_0”.

Claim 16, “(wall thickness), through the line tangent to A_i” appears to be incorrect and it appears that it should be “(wall thickness), through the line normal to A_i”.

Claim 16, “h_o = the external heat transfer of the external surface at area A_0” appears to be incorrect and it appears that it should be “h_o = the external heat transfer coefficient of the external surface at area A_0”.

Claims objected to but not specifically addressed are objected to based on their dependency to an objected claim.

Appropriate corrections are required.

Claim Rejections - 35 USC § 112

8. The following is a quotation of the second paragraph of 35 U.S.C. § 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

9. Claims 4, 5 and 8 are rejected under 35 U.S.C. § 112, second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01. The omitted steps are:

Claims 4 and 8 use the definition of variables E, $E_{conduction}$, $E_{convection}$, k, h_o and T_b. It is not clear how these are used in the calculation of h_i and if some steps are missing in the calculation.

Claim 5 relates to a method for optimizing the performance of a turbine engine. The method includes the steps of:

determining a heat transfer coefficient of an internal surface of an internal fluid passage of a turbine blade; and

balancing heat transfer between the internal surface of the internal fluid passage and the internal fluid with an external surface of the turbine blade and an external fluid.

However, one of ordinary skill in the art would understand that balancing the heat transfer between the internal surface and an external surface will not achieve optimizing the performance of a turbine engine. Additional steps are required to achieve optimal performance of a turbine engine. Applicants' attention is directed to Claim 1, step of:

redesigning and reevaluating the design of the interior fluid passage until the internal and external heat transfer are equal.

10. Claims 12 and 16 are rejected under 35 U.S.C. § 112, second paragraph, as being incomplete for omitting essential structural cooperative elements, such omission amounting to a gap between the necessary structural connections. See MPEP § 2172.01. The omitted structural cooperative relationships are:

11. Claims 12 and 16 use the definition of variables E, $E_{conduction}$, $E_{convection}$, k, h_o and T_b. It is not clear how these are used in the calculation of h_i and if the apparatus of claim 11 and claim 15 contain programming instructions using these variables and if these variables are used in the calculation of h_i.

Claim Rejections - 35 USC § 103

12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

13. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

14. Claims 1-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Nirmalan et al.** (U.S. Patent 6,422,743) in view of **Abdel-Messeh** (U.S. Patent 5,052,889).

14.1 **Nirmalan et al.** teaches method for determining heat transfer performance of an internally cooled structure. Specifically, as per claim 9, **Nirmalan et al.** teaches an apparatus comprising a storage medium comprising a plurality of programming instructions to enable a designer to use the apparatus; and

at least one processor coupled to the storage medium to execute the programming instructions (Fig. 7, Item 101; CL9 to CL40), to:

determine interior heat transfer at an interior area of an interior surface of an internal fluid passage of an actively cooled turbine blade, based at least in part on thermal data collected for the turbine blade (Fig. 3; CL1, L11-12; CL1, L40-50; Fig. 2; CL3, L58 to CL4, L2; CL5, L34-37);

determine external heat transfer at an exterior area of an exterior surface adjacent the interior area (CL5, L46-61).

Nirmalan et al. teaches relating the heat stored in an elementary volume to the heat transferred by internal convection and conduction from adjacent elementary volumes (CL5, L46-61). **Nirmalan et al.** does not expressly teach comparing the internal and external heat transfer to determine if they are equal. **Abdel-Messeh** teaches comparing the internal and external heat transfer to determine if they are equal (CL2, L7-10), because a turbine blade provided with a tailored internal heat transfer surface would achieve maximum cooling protection with least flow of internal cooling fluid; and increased operating efficiency with minimal costs would result (CL2, L10-14). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the apparatus of **Nirmalan et al.** with the apparatus of **Abdel-**

Messeh that included comparing the internal and external heat transfer to determine if they are equal. The artisan would have been motivated because a turbine blade provided with a tailored internal heat transfer surface would achieve maximum cooling protection with least flow of internal cooling fluid; and increased operating efficiency with minimal costs would result.

14.2 As per claim 10, **Nirmalan et al.** and **Abdel-Messeh** teach the apparatus of claim 9. **Nirmalan et al.** teaches that the apparatus further comprise a thermal imager equipped to allow the designer to supply the internal fluid passage with a fluid at a first temperature until the turbine blade reaches a first steady thermal state (CL4, L57-67; CL5, L13-18; CL6, L19-23);

measure and record the internal fluid pressure and internal and external fluid temperature and flow rate (CL2, L18-19; CL2, L27-31; Cl4, L57-67; CL5, L13-16; Cl5, L18-25; Cl6, L28-33);

supply the internal fluid passage with a fluid at a second temperature until the turbine blade reaches a second steady thermal state(CL4, L57-67; CL5, L13-18; CL6, L19-23); and

measure and record the exterior surface temperature, time between first and second steady thermal state, and internal and external fluid temperature and flow rate (CL2, L18-19; CL2, L27-31; Cl4, L57-67; CL5, L13-16; Cl5, L18-25; Cl6, L28-33).

14.3 As per claim 11, **Nirmalan et al.** and **Abdel-Messeh** teach the apparatus of claim 9. **Nirmalan et al.** teaches that the programming instructions further enable the designer to provide a distance between the internal surface and the corresponding external surface, and heat capacity, density, and thermal conductivity of the material comprising the component (CL5, L46-61); and calculate a heat transfer coefficient of the internal surface of the internal fluid passage (CL2, L19-21; CL5, L43-46).

14.4 As per claim 12, **Nirmalan et al.** and **Abdel-Messeh** teach the apparatus of claim 11. **Nirmalan et al.** teaches that the programming instructions are designed to calculate, as part of said calculating,

$h_i = (T_i - T_o)^* [C_p *p*V]/[A_i * t_{imaged} *(T_a - T_i)]$ (**Nirmalan et al.:** CL5, L46-61)

where: T_a = temperature of the internal fluid at point i and of a small arbitrary area A_i through which a tangent line to the internal surface of the internal passage passes;

h_i = an internal heat transfer coefficient at the internal surface of the internal passage at area A_i through which the same line referenced in the definition of T_a passes;

T_i = an internal temperature at the internal surface of the internal passage at area A_i;

T_o = an external temperature of the component at a point o and of a small area A_o through which the same line referenced in the definition of T_a passes, as measured at some time t_{imaged} during the test t_o, or zero time;

w = a distance between points i and o, or the internal surface and external surface of the component (wall thickness), through the line tangent to A_i and the outer surface of the component;

V = a volume defined by A_i *w, measured in (m^3);

E = the energy stored in the volume V around the line drawn referenced in the definition of T_a after the time t_{test}, measured in Joules, or (J);

$E_{conduction}$ = energy imparted to the component due to conduction, as conducted through the small volume V;

$E_{convection}$ = energy imparted to the component at the area A_i by the internal fluid through convection;

C_p = heat capacity of the material of the component;

p = density of the material comprising the component;

k = the thermal conductivity of the material comprising the component;

h_o = external heat transfer of the external surface at area A_o; and

T_b = temperature of the external fluid, wherein:

$E_{conduction}$ or E is defined by $E_{conduction} = E = k^* A_i * t_{imaged} *(T_i - T_o)/w$.

14.5 As per claim 13, **Nirmalan et al.** teaches an apparatus comprising a storage medium having stored therein a plurality of programming instructions to enable a designer; and

at least one processor coupled to the storage medium to execute the programming instructions (Fig. 7, Item 101; CL9 to CL40), to:

determine a heat transfer coefficient of an internal surface of an internal fluid passage of a turbine blade (CL5, L34-37; CL5, L46-61).

Nirmalan et al. teaches relating the heat stored in an elementary volume to the heat transferred by internal convection and conduction from adjacent elementary volumes (CL5, L46-61). **Nirmalan et al.** does not expressly teach balancing the heat transfer between the internal surface of the fluid passage and the internal fluid with an external surface of the turbine blade and an external fluid. **Abdel-Messeh** teaches balancing the heat transfer between the internal surface of the fluid passage and the internal fluid with an external surface of the turbine blade and an external fluid (CL2, L7-10), because a turbine blade provided with a tailored internal heat transfer surface would achieve maximum cooling protection with least flow of internal cooling fluid; and increased operating efficiency with minimal costs would result (CL2, L10-14). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the apparatus of **Nirmalan et al.** with the apparatus of **Abdel-Messeh** that included balancing the heat transfer between the internal surface of the fluid passage and the internal fluid with an external surface of the turbine blade and an external fluid. The artisan would have been motivated because a turbine blade provided with a tailored internal heat transfer surface would achieve maximum cooling protection with least flow of internal cooling fluid; and increased operating efficiency with minimal costs would result.

14.6 As per Claims 14, 15 and 16, these are rejected based on the same reasoning as Claims 10, 11 and 12, supra. Claims 14, 15 and 16 are apparatus claims reciting the same limitations as Claims 10, 11 and 12, as taught throughout by **Nirmalan et al.** and **Abdel-Messeh.**

14.7 As per claim 1, **Nirmalan et al.** teaches method for designing an actively cooled turbine blade having an internal fluid passage (Fig. 3; CL1, L11-12; CL1, L40-50; Fig. 2; CL3, L58 to CL4, L2); comprising:

determining interior heat transfer at an interior area of an interior surface of the fluid passage (CL5, L34-37);

determining external heat transfer at an exterior area of an exterior surface adjacent the interior area (CL5, L46-61); and

redesigning and reevaluating the design of the interior fluid passage until the internal and external heat transfer are equal (CL6, L51-57).

Nirmalan et al. teaches relating the heat stored in an elementary volume to the heat transferred by internal convection and conduction from adjacent elementary volumes (CL5, L46-61). **Nirmalan et al.** does not expressly teach comparing the internal and external heat transfer. **Abdel-Messeh** teaches comparing the internal and external heat transfer (CL2, L7-10), because a turbine blade provided with a tailored internal heat transfer surface would achieve maximum cooling protection with least flow of internal cooling fluid; and increased operating efficiency with minimal costs would result (CL2, L10-14). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the apparatus of **Nirmalan et al.** with the apparatus of **Abdel-Messeh** that included comparing the internal and external heat transfer. The artisan would have been motivated because a turbine blade provided with a tailored internal heat transfer surface would achieve maximum cooling protection with least flow of internal cooling fluid; and increased operating efficiency with minimal costs would result.

14.8 As per Claims 2, 3 and 4, these are rejected based on the same reasoning as Claims 10, 11 and 12, supra. Claims 2, 3 and 4 are method claims reciting the same limitations as Claims 10, 11 and 12, as taught throughout by **Nirmalan et al.** and **Abdel-Messeh.**

14.9 As per Claims 5-8, these are rejected based on the same reasoning as Claims 13-16, supra. Claims 5-8 are method claims reciting the same limitations as Claims 13-1612, as taught throughout by **Nirmalan et al.** and **Abdel-Messeh.**

Conclusion

15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 703-305-0043, till October 27, 2004 and 571-272-3717 after October 27, 2004. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska, can be reached on (703) 305-9704, till October 27, 2004 and 571-272-3716 after October 27, 2004. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-9600.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

K. Thangavelu
Art Unit 2123
October 16, 2004

KEVIN J. TESKA
SUPERVISORY
PATENT EXAMINER